

# Claims

[c1] WHAT IS CLAIMED IS:

1. A buckling arm robot for machining workpieces with laser radiation, the buckling arm robot comprising:  
at least a first axis, a second axis, a third axis, a fourth axis, and a fifth axis;  
a laser device arranged on the second axis and configured to emit a laser beam;  
wherein the laser beam emitted by the laser device is guided within the third, fourth, and fifth axes before striking a workpiece to be machined.

[c2] 2. The buckling arm robot according to claim 1, wherein the fifth axis is a robot hand, wherein a sixth axis is arranged in the robot hand and extends transversely to the fifth axis.

[c3] 3. The buckling arm robot according to claim 2, further comprising a first drive for the sixth axis, wherein the fourth axis has a housing and wherein the first drive is arranged in the housing of the fourth axis.

[c4] 4. The buckling arm robot according to claim 3, further comprising a second drive for the fifth axis, wherein the

second drive is arranged in the housing of the fourth axis.

- [c5] 5. The buckling arm robot according to claim 4, wherein the first and second drives each have a drive shaft, wherein the drive shafts of the first and second drives extend parallel to the fourth axis in a direction toward the robot hand.
- [c6] 6. The buckling arm robot according to claim 5, wherein the first and second drives each comprise bevels gears, wherein the drive shafts drive the bevel gears.
- [c7] 7. The buckling arm robot according to claim 1, wherein, in operation of the laser device, the laser beam is guided essentially laterally along an arm structure extending between the second and third axes and impinges perpendicularly onto the third axis.
- [c8] 8. The buckling arm robot according to claim 1, wherein the third axis is a drivable hollow shaft.
- [c9] 9. The buckling arm robot according to claim 1, further comprising a beam guiding system comprising mirrors, wherein, in operation of the laser device, the laser beam is guided by the beam guiding system onto a workpiece, wherein the beam guiding system is arranged within the third, fourth, and fifth axes.

[c10] 10. The buckling arm robot according to claim 9, wherein the mirrors are arranged such that, in operation of the laser device, the laser beam is displaced, in an area proximal to the fifth axis, relative to the fourth axis before being directed onto the fifth axis and, on the fifth axis, is directed onto the workpiece.

[c11] 11. The buckling arm robot according to claim 9, wherein a first one of the mirrors is arranged such that the first mirror directs the laser beam substantially concentrically to the third axis onto a second one of the mirrors, wherein the laser beam is directed by the second mirror substantially concentrically to the fourth axis onto a third one of the mirrors, wherein, in order to provide free rotatability of the fifth axis, the third mirror directs the laser beam transversely to the fourth axis outwardly onto a fourth one of the mirrors, wherein the fourth mirror guides the laser beam approximately parallel to the fourth axis onto a fifth one of the mirrors, wherein the fifth mirror guides the laser beam transversely to the fourth axis inwardly onto a sixth one of the mirrors, wherein the sixth mirror is arranged at a point of intersection of the fourth and fifth axes, wherein the laser beam is directed by the sixth mirror onto a workpiece.

- [c12] 12. The buckling arm robot according to claim 9, wherein the beam guiding system has four of the mirrors.
- [c13] 13. The buckling arm robot according to claim 12, wherein a first one of the mirrors is arranged such that the laser beam emitted by the laser device is guided substantially concentrically to the third axis and perpendicularly to the fourth axis onto a second one of the mirrors, wherein the second mirror is received in a mirror guide and guides the laser beam upon rotation of the fourth axis on a conical envelope surface in a defined way to a third one of the mirrors, wherein the third mirror upon rotation of the fourth axis is moved on a circular path, and wherein the laser beam is guided by the third mirror onto a fourth one of the mirrors directing the laser beam onto a workpiece.
- [c14] 14. The buckling arm robot according to claim 13, wherein the mirror guide is comprised of a base member, a mirror receptacle, a coupling gear, and a connecting element, wherein the base member of the mirror guide is rotatably supported for rotation about the third axis.
- [c15] 15. The buckling arm robot according to claim 14, wherein a movement of the third mirror on the circular

path is transmitted by the connecting element onto the mirror guide.

[c16] 16. The buckling arm robot according to claim 14, wherein the connecting element is configured to be positively mechanically guided or to be moved by actuators operated by external energy.

[c17] 17. The buckling arm robot according to claim 16, wherein the connecting element is a protective pipe positioned on a connecting axis of the second and third mirrors.

[c18] 18. The buckling arm robot according to claim 16, wherein the fifth axis is a robot hand, wherein the connecting element has a first end connected to the base member of the mirror guide by a joint, wherein the joint has an axis extending perpendicularly to an axis of rotation of the base member and extending through a point of intersection of the third and fourth axes, wherein the connecting element has a second end connected to the robot hand.

[c19] 19. The buckling arm robot according to claim 15, wherein the coupling gear connects the connecting element to the mirror receptacle and is a planetary gear.

[c20] 20. The buckling arm robot according to claim 19,

wherein the planetary gear comprises a first sun wheel fixedly connected to the base member and a second sun wheel fixedly connected to the connecting element, wherein the planetary gear further comprises two planet wheels that are fixedly connected to one another equiaxially and are connected rotatably to the base member.

[c21] 21. The buckling arm robot according to claim 13, wherein an angle between a mirror surface of the second mirror and the fourth axis in a cutting plane thereof is  $\alpha_2 = 45^\circ \pm \arctan a_3 / a_2 \cdot 0.5$ ; wherein  $a_2$  is a spacing of the second and third mirrors relative to one another and  $a_3$  is a spacing of the third and fourth mirrors relative to one another, wherein the sign depends on a position of the fourth axis in space.

[c22] 22. The buckling arm robot according to claim 13, wherein an angle between a mirror surface of the third mirror and the fifth axis in a cutting plane thereof is  $\alpha_3 = 45^\circ - \arctan a_3 / a_2 \cdot 0.5$ ; wherein  $a_2$  is a spacing of the second and third mirrors relative to one another and  $a_3$  is a spacing of the third and fourth mirrors relative to one another.

[c23] 23. The buckling arm robot according to claim 1, wherein an interior of the beam guiding system is sealed relative to drives of the first, second, third, fourth, and

fifth axes.

- [c24] 24. The buckling arm robot according to claim 1, wherein the laser device is adjustable.
- [c25] 25. The buckling arm robot according to claim 1, wherein a length of the fourth axis is preselectable.
- [c26] 26. The buckling arm according to claim 1, comprising a processing gas supply.
- [c27] 27. The buckling arm robot according to claim 1, wherein the laser device is freely selectable with regard to laser beam generation.
- [c28] 28. The buckling arm robot according to claim 1, wherein the laser device comprises a laser beam guiding fiber.
- [c29] 29. The buckling arm robot according to claim 1, comprising a beam guiding system for guiding the laser beam, wherein the beam guiding system comprises four mirrors and an optical element.
- [c30] 30. The buckling arm robot according to claim 29, wherein the optical element is a beam diverting prism.